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NEW RECORDS OF BENTHIC MARINE ALGAE FROM THE SULTANATE OF OMAN

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INTRODUCTION

A prior publication has stressed the relative paucity of work on the marine algal flora of the northern Arabian Sea, particularly the coast of Oman (Wynne & Jupp 1998). Ongoing investigations based on my own collections as well as those made by the Tropical Marine Research Unit of York University, U.K., have led to the recognition of some additional new records and new taxa for this region (Wynne 1998). Some of these new records represent interesting range extensions. The sublittoral and littoral shoreline of southern Oman is greatly influenced by the summertime monsoon with its accompanying upwelling of relatively colder, nutrient-rich waters as well as by the high-energy conditions. In contrast to the elevated salinity values, namely 43.0‰ to 65‰ (–80‰), reported by Basson et al. (1989) for Bahrain in the Arabian (Persian) Gulf, salinity values for the Omani coast have been reported by Savidge et al. (1990) to be close to normal and showing little variation (in the range of 35.5‰ and 35.7‰, rarely in excess of 36.0‰). It is anticipated that this further research on this region will continue to reveal a very rich species diversity of the benthic marine algal flora. All of the specimens referred to in this account have been deposited in the University of Michigan Herbarium (MICH), Ann Arbor. For the specific locations of the collection sites, see Fig. 1 in Wynne and Jupp (1998). The names of authors of taxa are cited according to Brummitt and Powell (1992). “TMRU” indicates that the collections were made by unnamed personnel of the Tropical Marine Research Unit of York University.

RHODOPHYTA

PORPHYRIDIALES

Porphyridiaceae

Stylonema alsidii (Zanardini) K. M. Drew

OMAN. Shinzi, Masirah Island: 6. ii. 1997, *Wynne 10935*, epiphytic on *Polysiphonia* sp.; Jazirat Thukahr, Masirah Island: 7. ii. 1997, *Wynne 10928-B*, epiphytic on *Ceramium truncatum* H. E. Petersen in Børgesen.

This widely distributed microscopic alga, which is a common epiphyte on larger seaweeds, has not previously been reported from Oman. *Stylonema* is a genus comprising four species (Kajimura 1992), of which *S. alsidii* is the most frequently reported. Wynne (1985a) reported on the nomenclature of this genus, previously known as *Goniotrichum*.

ERYTHROPELTIDALES

Erythrotrichiaceae

Erythrotrichia vexillaris (Mont.) Hamel

Figs. 1–5.

OMAN. Wadi Forh, 6 km east of Sath: 2. viii. 1985, leg. T. Wrathall, 1–3 m., epiphytic on *Jolyna laminarioides* Guimarães.

This algal species is in the form of small blades on its host. The young germ-lings (Figs. 1, 2) form simple uniseriate filaments attached by a single rhizoidal cell. The filaments soon flatten out into blades (Figs. 3, 4). Later the mature monostromatic blades are attached by numerous rhizoidal cells produced from the basal part of the blade (Fig. 5). Blades become 1.5–2.0 mm wide and 4.0–5.0 mm long. Taylor (1942) depicted a series of developmental stages, and the Omani material agrees with those figures in having a single attachment cell in the younger stages and multiple rhizoidal cells at the base of larger blades. Vegetative cells are variable in size but are mainly 6–8 μm wide and 7–10 μm long. Reproductive cells were not detected. *Erythrotrichia vexillaris* was originally described from Martinique in the West Indies (Montagne 1856); the only previous record of this species from the Indian Ocean is that by Gepp and Gepp (1905) from Christmas Island southwest of Java.

Another foliose species of *Erythrotrichia* is South and Adams's (1974) *E. foliiformis*, described from New Zealand and also reported from Tasmania (Womersley 1994). That species has blades reaching only 0.5 mm in width, but the cell dimensions of the two species, based on my measurements of the Omani specimens and those reported for *E. foliiformis* by South and Adams (1974), are the same. According to Taylor (1942) width of cells varies according to the age of the plant and the recentness of division: before division 13–15 μm wide and after division 7.5–10.9 μm wide. Filamentous cells assuming a stellate shape in the blades of *E. foliiformis* (of unknown function) are not reported in *E. vexillaris*. Womersley (1994) described *E. ligulata* from southern Australia, a small foliose species with numerous simple ligulate blades arising from a well-developed multicellular basal disc. Womersley expressed doubt that *E. vexillaris* and *E. foliiformis* belong to *Erythrotrichia* because of their multi-rhizoidal bases.

GIGARTINALES

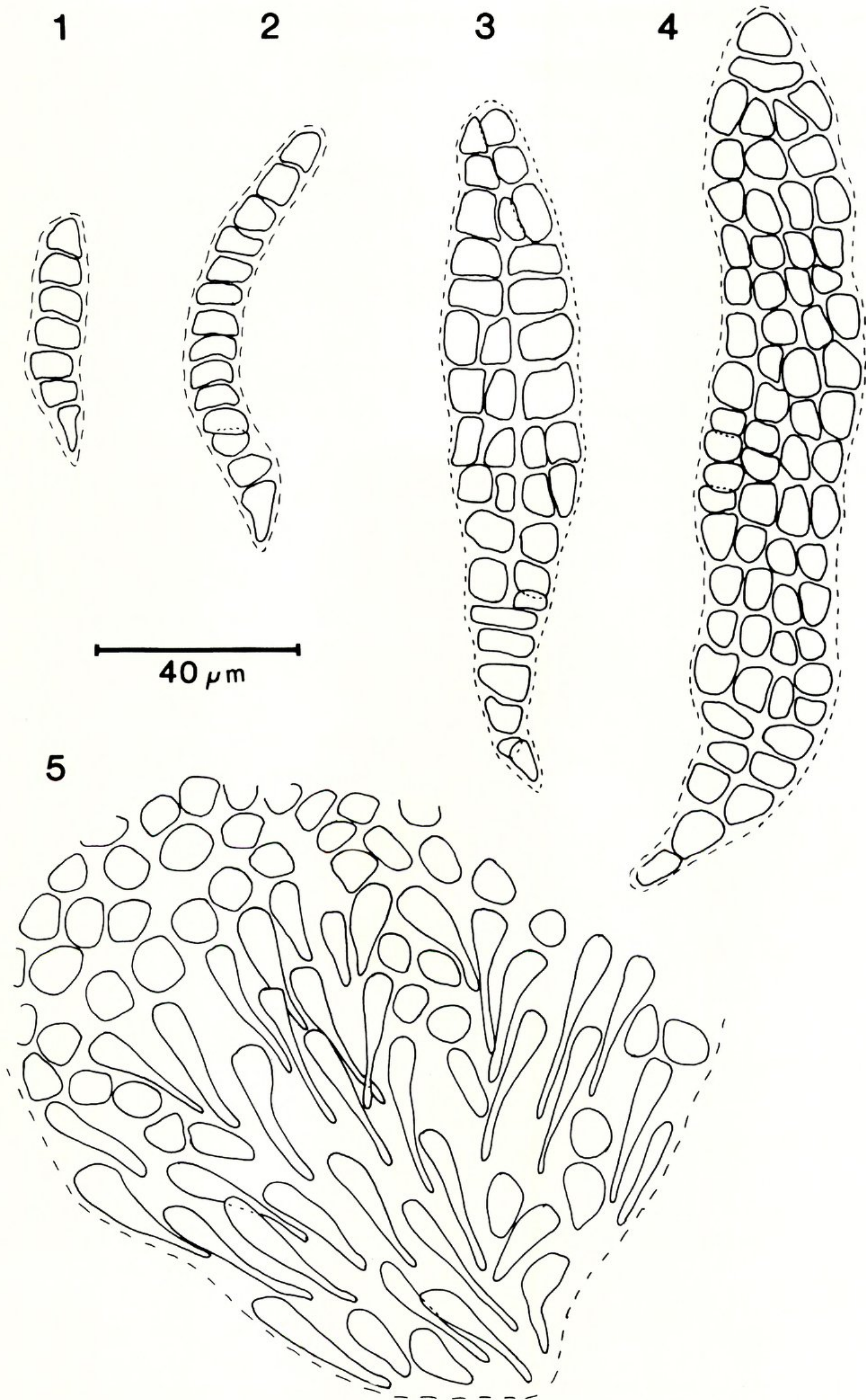
Rhizophyllidaceae

Portieria japonica (Harv.) P. C. Silva

OMAN. Raysut: 23. iv. 1983, intertidal pools; leg. L. Barratt.

This species was first described by Harvey (1860, as *Desmia japonica*) from Shimoda (Shizuoka Prefecture) Japan. It was later transferred to *Chondrococcus* by DeToni (1895). Silva (in Silva et al. 1987) explained that the generic name *Chondrococcus* (Kützing 1847) could no longer be used for the material being assigned to it, and he resurrected the generic name *Portieria* (Zanardini 1851) to encompass those species formerly assigned to *Chondrococcus*.

Portieria hornemannii (Lyngb.) P. C. Silva, the type of the genus, is a much more frequently encountered species and has a much broader distribution than *P. japonica*. The former species has been reported from Oman (Silva et al. 1996). Okamura (1922, pl. 190) depicted both *P. hornemannii* and *P. japonica* from



FIGS. 1-5. *Erythrotrichia vexillaris*. 1, 2. Young filamentous germlings. 3, 4. Early foliose stages. 5. Numerous rhizoidal cells from basal attachment portion of a mature thallus.

Japan. He indicated that *P. japonica* differs in the breadth of the frond: 2–3 mm broad in comparison to 1–2 mm broad in *P. hornemannii*. The ultimate branches in *P. japonica* tend to be blunt and obtuse rather than the sharply pointed, simple or divaricately branched final branches of *P. hornemannii*. Also, branching in *P. hornemannii* is often to 5 orders, whereas in *P. japonica* branching is to 3 orders. The Oman specimen assigned to *P. japonica* is 11 cm in height, branched to 5 orders, and has axes reaching 2.5 mm in width. This record represents the first report of *P. japonica* from the Indian Ocean.

Hypneaceae

Hypnea boergesenii Tak. Tanaka

Fig. 6.

OMAN. Al Halaaniyaat Islands (formerly Kuria Muria Islands), southeast bay on runway: 22. x. 1983, leg. TMRU; tetrasporangiate and cystocarpic plants.

Tanaka (1941) distinguish ~6 *Hypnea boergesenii* from the 13 other species in his monographic treatment of the genus on the basis of the erect main axes that are cylindrical and densely bearing lateral branchlets throughout the length of the frond of this species. These features are also characteristic of the specimens from Oman (Fig. 6). Tanaka (1941) reported the height of his material to be 6–13 cm; the height of the Omani plants reaches 32 cm. Tanaka regarded his new species to be closely related to *H. spicifera* Harv. but differing by its axial stem and the shape of its spinous branchlets. This species has been characterized by Dawson (1954) as having exceedingly abundant, short ultimate lateral branchlets, the tips of some of these ultimate branchlets divaricate. A closely related species is *H. flagelliformis* Grev. ex J. Agardh (1852), which also has axes densely covered with simple or divaricate branchlets or spinules (Yendo 1916). Tanaka (1941) separated the species by the absence of lateral branches in the basal part of the frond of *H. flagelliformis*. Also, lenticular wall thickenings of the medullary cells do not occur in *H. flagelliformis* but are present in the basal part of the frond of *H. boergesenii* (Chiang 1997; Xia & Wang 1997).

Hypnea boergesenii was described by Tanaka (1941) from Keelung, northern Taiwan (see also Chiang, 1997), and has also been reported from central to southern China (Tseng 1983; Xia & Wang 1997), Vietnam (Dawson 1954), and New South Wales, Australia (Millar 1990). It has not yet been reported from Japan (Yoshida et al. 1995), and its only previous reports from the Indian Ocean have been by Isaac (1968) from Kenya and by Islam (1976) from Bangladesh.

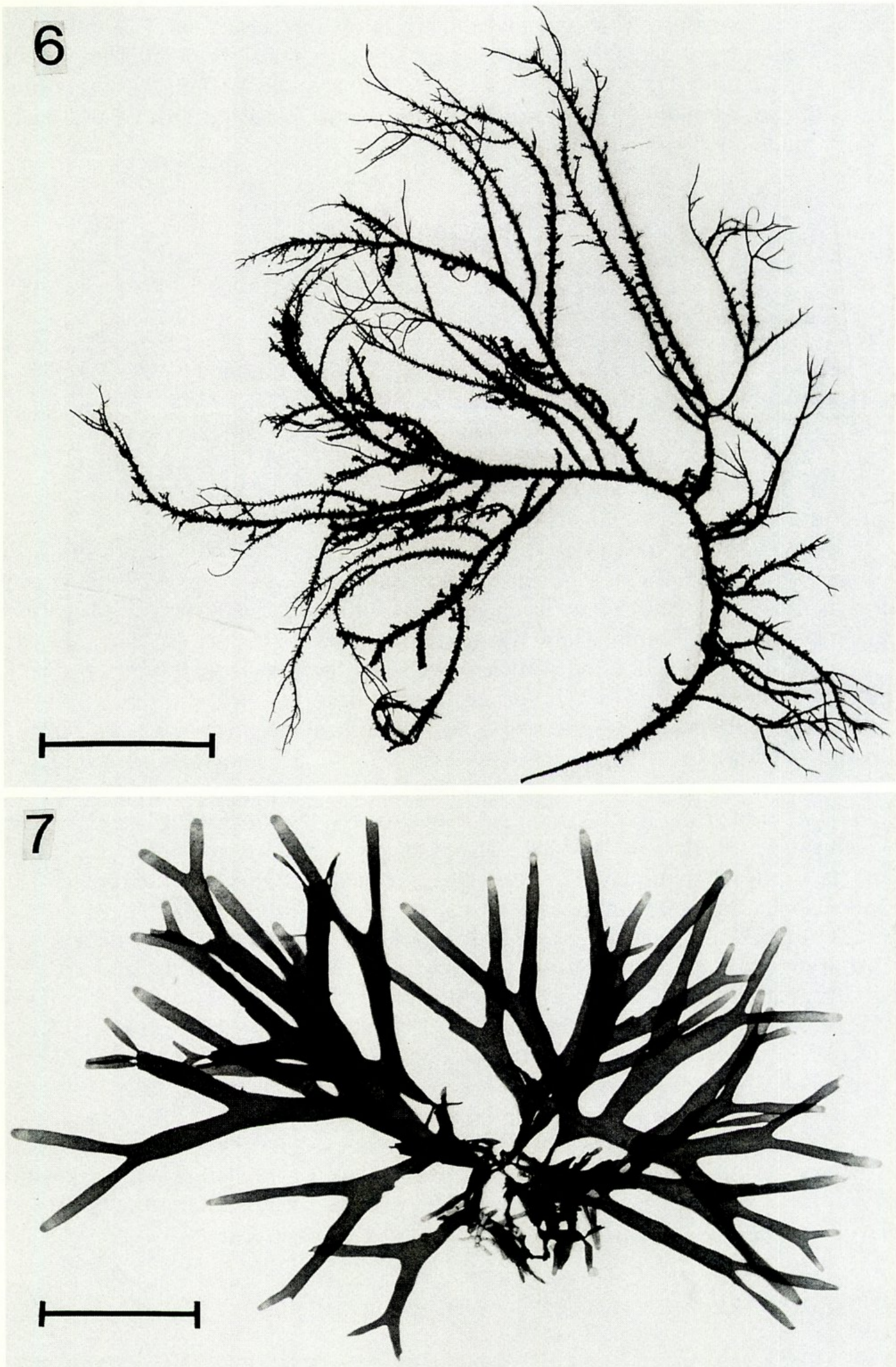
HALYMENIALES

Halymeniaceae

Cryptonemia coriacea F. Schmitz

OMAN. Sadh headland: 20. ix. 1985, T. Cadle, 16 m depth.

Originally described from Tanzania (Schmitz 1895), *Cryptonemia coriacea* has also been reported from India and Pakistan by Børgesen (1937). Børgesen (1937) recognized that the very large Karachi specimens that he had identified earlier as *C. undulata* Sond. (Børgesen 1932) should be referred to *C. coriacea*. According to Børgesen specimens of *C. undulata* are much smaller, more delicate, and with a very much undulated margin. Similarly, Desikachary et al. (1990) distinguished *C. coriacea*



FIGS. 6, 7. *Hypnea boergesenii* and *Rhodymenia dissecta*. 6. *Hypnea boergesenii*, habit of pressed specimen (scale bar: 5 cm). 7. *Rhodymenia dissecta*, habit of pressed specimen (scale bar: 2 cm).

from *C. undulata* in that the former has marginal proliferations rather than proliferations arising only from the midrib; the branching of *C. coriacea* results in blades that are palmately or irregularly divided rather than the dichotomous pattern of *C. undulata*. The single Omani specimen has small marginal proliferations. In both species there is a prominent midrib in the basal portion of the blade, which gradually disappears in the upper portion.

RHODYMENIALES

Rhodymeniaceae

Rhodymenia dissecta Børgesen

Fig. 7.

OMAN. Wadi Haart Reef: 7. x. 1983, leg. TMRU, 6 m. and 12 m., *Sargassum* community. Western side of Wadi Zead ("Hoon's Bay"), 20 km east of Mirbat: 21. x. 1983, leg. TMRU, 17 m., *Ecklonia* forest. Sath headland: 20. ix. 1985, leg. T. Cadle, 15 m., *Ecklonia* community. Ras Shabana: 31. x. 1986, leg. TMRU, 9 m., rock/sand interface, ♂. Wadi Feshree: 15. xi. 1986, leg. TMRU, 9 m., on sand/coral substrate, ⊕.

Børgesen (1938) described this species from Tuticorin, India, and it has been also reported from Yemen (Ormond & Banaimoon 1994). The eight specimens assigned to this species range in height from 5 to 10 cm, and their axes in width generally from 2 to 4 mm. There is a gradual reduction in blade width in the distal portions, the final orders of branches becoming narrowed to 1 mm. One large tetrasporangiate specimen is branched up to 9 orders, which exceeds the "up to six times" reported by Børgesen (1938). A terete stoloniferous system is lacking. In the specimens with intact basal systems (Fig. 7), attachment to the substrata (usually articulated coralline red algae) is made by multiple points arising from the basal part of the *Rhodymenia*, and some of the tips of smaller branches have produced small, narrow holdfasts. Marginal proliferations are not present near the base, but tetrasporangia are present in sori near the apices of the regular axes and also on small proliferations arising near the blade margins. These fertile proliferations are 5 mm long and 1.2–1.8 mm wide. The cruciately divided tetrasporangia are elongate-ovoid, 14–18 μm long and 7–10 μm wide, and are produced in nemathecia. Cross-sections of mature blades measure 160–190 μm in thickness. The walls of some medullary cells were unevenly thickened and refractive, a feature not previously known to occur in *Rhodymenia* but common in some species of *Hypnea*, *Laurencia*, and *Chondria*.

This species bears similarity to *Rhodymenia leptophylla* J. Agardh, known from New Zealand (Adams 1994) and Australia (Millar 1990; Womersley 1996). That species has a stoloniferous basal system and a terete stipe unlike the flattened basal stalk of *R. dissecta*. There also is some resemblance to *R. natalensis* Kylin and *R. sonderi* P. C. Silva (formerly *R. australis* Sond.).

CERAMIALES

Ceramiaceae

Ceramium mazatlanense E. Y. Dawson

OMAN. Sur Beach Resort Hotel, Sur: 31. i. 1997, Wynne (*Oman* 255), sterile, in sandy turf with other algae.

First described from Pacific Mexico (Dawson 1950), this species has been recorded to have a broad distribution in the tropical and subtropical Indo-Pacific (Dawson 1954; Jaasund 1970; Womersley & Bailey 1970; Cribb 1983; Wynne 1995). Although the Omani material was apparently sterile, the species determination could be made on the basis of the prostrate habit, the reduced stature, the dichotomous branching and strongly forcipate tips, and the nodal cortication comprised of angular cells in a non-regular alignment.

Ceramium subdichotomum Weber Bosse

Figs. 8. 9.

OMAN. Jazirat Thukhayr, Masirah Island: 7. ii. 1997, *Wynne 10962*, epiphytic on *Padina*.

This species, described from Indonesia (Weber-van Bosse 1923), has also been reported from India (Børgesen 1938) and the Seychelles (Wynne 1995). Significant points of agreement with *Ceramium subdichotomum* are the primary creeping filament, the overall small size of the thallus, the subdichotomous branching (Fig. 8), the mature axes reaching a width of 150 to 350 μm , and the mature segments having a greater width than length. A conspicuous feature of the Omani material is the abundant presence of gland cells scattered in among the nodal cells (Fig. 9), a character not noted by Weber-van Bosse (1923) in her account. Yet this determination seems justified in light of the other similarities and the fact that the presence of gland cells is not considered a reliable character (Womersley 1978).

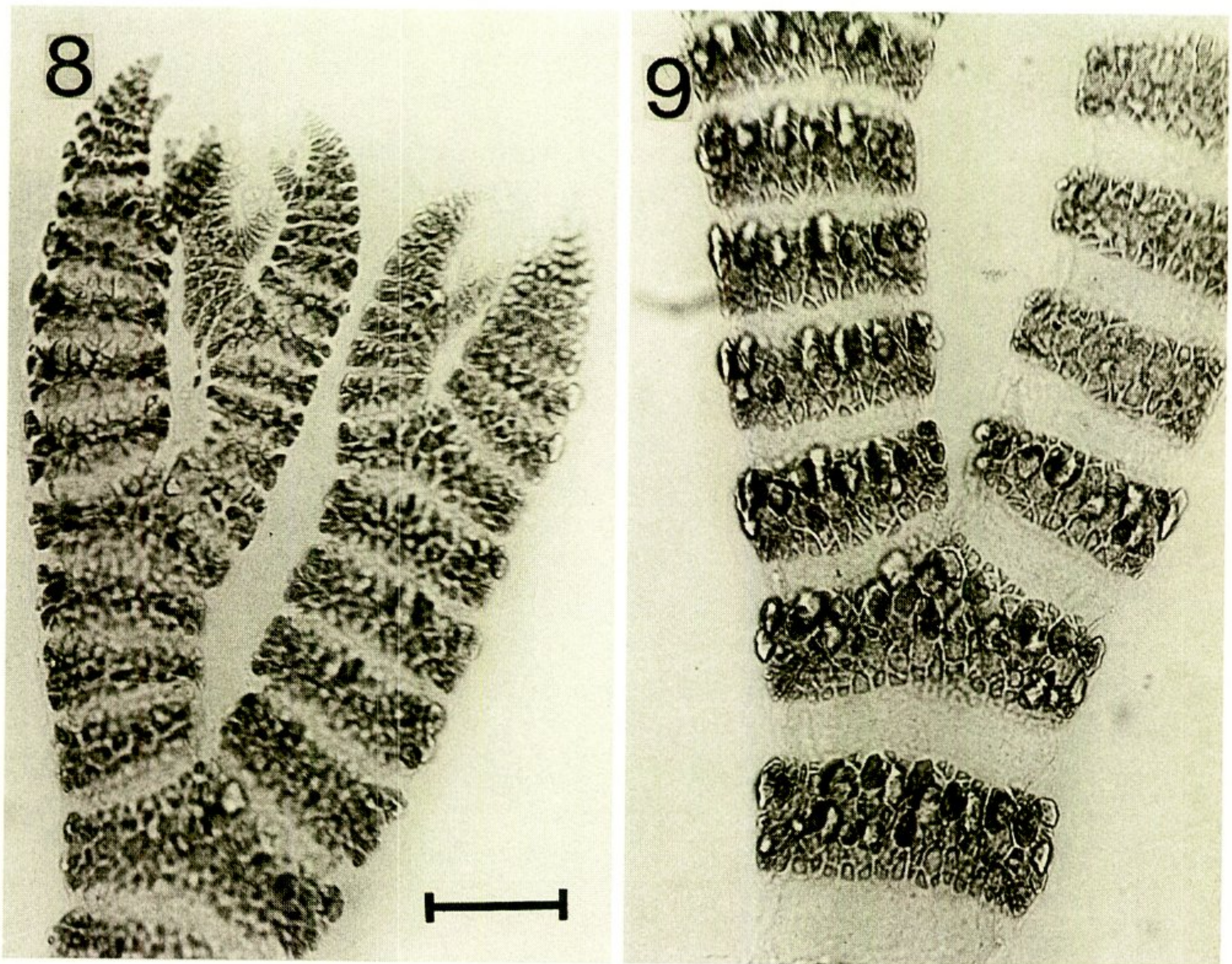
The Omani material shows a great amount of morphological variation. Thalli showing greatest similarity to Weber-van Bosse's (1923) description of *Ceramium subdichotomum* appear to be those no longer exhibiting active growth (Fig. 8), whereas the more actively growing plants have apices more strongly forcipate and with nodes separated by longer and narrower internodes. A transition between these two patterns is obvious.

Several other species of *Ceramium* are known to have gland cells present in among their nodal cells. For example, *C. glanduliferum* Kylin from South Africa has a ring of 5 to 10 yellow-brown ovoid gland cells, but they are restricted to a whorl at the distal end of each nodal band (Kylin 1938; Stegenga et al. 1997). In *C. clarionense* Setch. & N. L. Gardner the nodal bands contain a large number of scattered small gland cells (Setchell & Gardner 1930). The axes in that species, however, show regularly dichotomous branching with circinate-forcipate apices. Gland cells may occur in *C. flaccidum* (Kütz.) Ardiss. That species differs from *C. subdichotomum* in having its cortical bands separated into acropetal and basipetal parts by a horizontal space (Womersley 1978).

Ceramium truncatum H. E. Petersen in Børgesen

OMAN. Sath, Dhofar: 20. ix. 1985, *L. Barratt*, epiphytic on foliose red algae; Shinzi, Masirah Island: 6. ii. 1997, *Wynne 10889*, \oplus , epiphytic on *Meristotheca papulosa* (Mont.) J. Agardh; Jazirat Thukhayr, Masirah Island: 7. ii. 1997, *Wynne 10928-A*, \oplus , epiphytic on *Meristotheca papulosa*.

In addition to its epiphytic habit, other points of agreement between the Omani collection and Petersen's (in Børgesen, 1936) account of *Ceramium truncatum* are the erect (non-forcipate) nature of the apices, and the fact that the cortication is continuous close to the growing points but becoming distinct in older axes. The cruciately divided tetrasporangia are usually paired but also borne singly per segment and in three's (whorled), and covered by outer involucreal filaments. Axes are 80–88 μm wide, and nodal bands consist of about 6 or 7 irregularly arranged rows of cells.



FIGS. 8, 9. *Ceramium subdichotomum*. 8. Apices showing subdichotomous branching. 9. Gland cells abundantly present in the nodal bands. Scale bar: 50 μ m.

Dasyaceae

Dasya rigidula (Kütz.) Ardiss.

OMAN. Shinzi, Masirah Island: 6. ii. 1997, Wynne 10932; epiphytic on *Spyridia hypnoides* (Bory) Papenf.

This report of *Dasya rigidula* from Oman appears to represent the first record of this species from the Indian Ocean. First described from Split in the Adriatic by Kützting (1843, 1849, as ?*Eupogonium rigidulum*), its distribution was later extended into the western Mediterranean (Ardissone 1883; Gallardo et al. 1985; Boudouresque & Perret-Boudouresque 1987), Atlantic Iberian Peninsula (Ardré 1970), and to the tropical and subtropical western Atlantic (Howe 1920; Taylor 1960; Oliveira & Ugadim 1974; Schneider & Searles 1991). Thalli of *D. rigidula* are small (1–2 cm tall), and the axes are typically ecorticate but becoming lightly corticated in basal regions. Pseudolaterals are borne from every segment in a radial arrangement, and the branches of the pseudolaterals are divaricate. The basal segment of the pseudolaterals are monosiphonous; indeterminate branches occasionally replace pseudolaterals. *Dasya rigidula* can possibly be confused with *Heterosiphonia crispella* (C. Agardh) M. J. Wynne, but the latter species, which is also very lightly corticated, has bilaterally arranged pseudolaterals, arising from every other segment and provided with a polysiphonous basal segment (Wynne 1985b).

There is some similarity between *Dasya rigidula* and *D. iyengarii* Børgesen, described from India (Børgesen 1937). Thalli of *D. iyengarii* are described as forming small, dense, soft, much ramified tufts, 3–4 cm high, with weakly developed

cortication. But unlike the divaricate branches of the pseudolaterals in *D. rigidula*, those in *D. iyengarii* are curved and hook-shaped (Børgesen 1937; Krishnamurthy & Varadarajan 1991).

The relationship of *Dasya rigidula* with *D. hutchinsiae* Harv. is uncertain. It has been suggested by Athanasiadis (1987) that the former may be a taxonomic synonym of the latter. Athanasiadis (1987) found small (to 2 cm tall) specimens with sparse cortication from the Sithonia Peninsula in the northern Aegean Sea, and he thought that earlier reports of *D. rigidula* from the region by Coppejans (1974) corresponded to his material of *D. hutchinsiae*. Schneider and Searles (1991) reported *Dasya rigidula* from North Carolina, noting that specimens from Onslow Bay were significantly larger (to 8 cm) than the 2 cm height reported by Taylor (1960) for *D. rigidula* in the western Atlantic. Schneider and Searles (1991) also noted that the main axes of these larger specimens showed more cortication than the smaller, mostly ecorticate specimens, but these authors made no reference to *D. hutchinsiae*.

Delesseriaceae

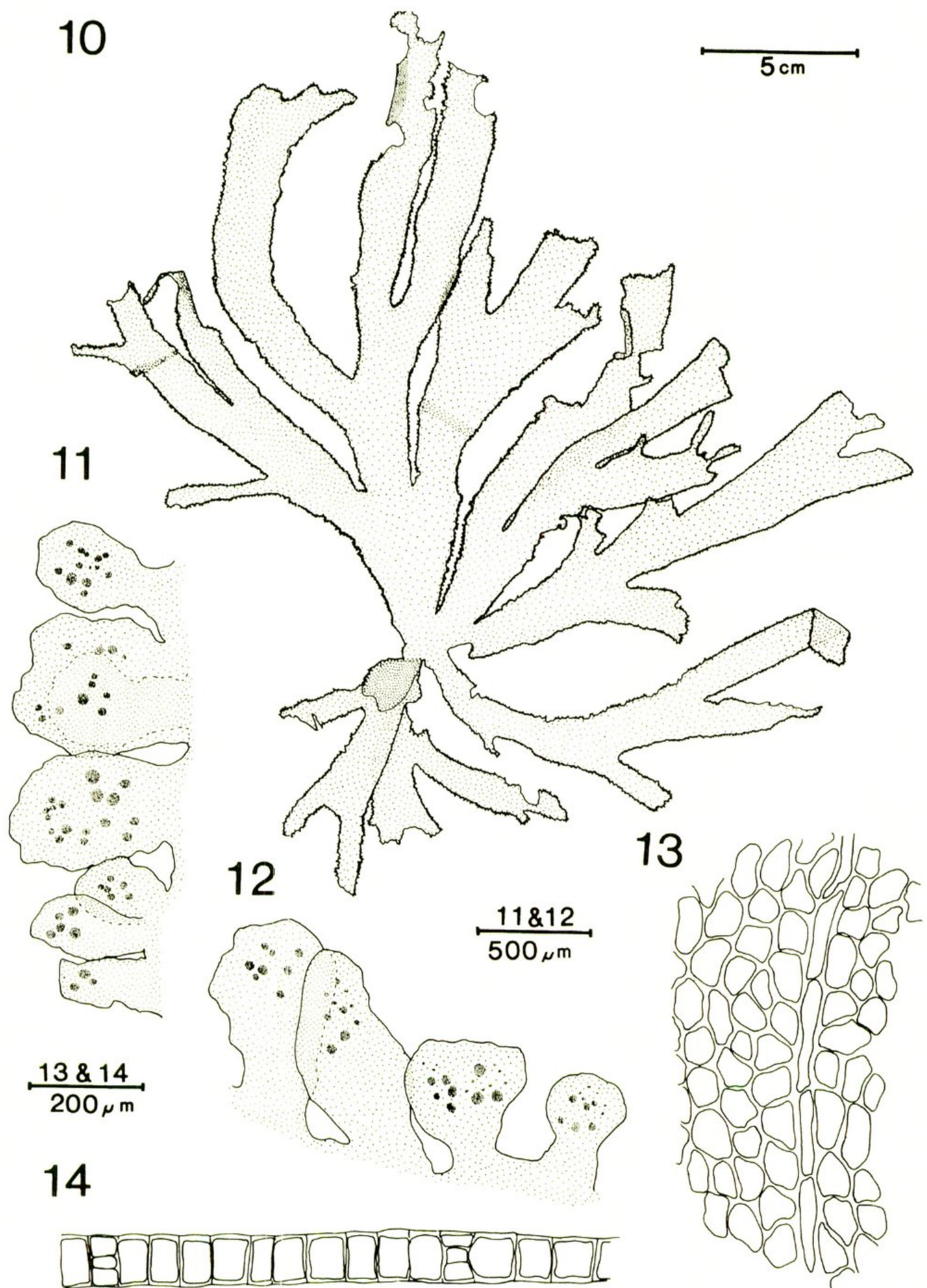
Cryptopleura robusta M. J. Wynne, sp. nov.—TYPE: OMAN. Sadh headland, west of Sadh Bay: 21. xi. 1985, L. Barratt, 25 m. depth; ⊕ (holotype: MICH!).

Figs. 10–14.

Thallus atroruber, usque ad 21 cm altus; segmenta plana ramificatione dichotoma vel trichotoma, usque ad quattuor ordines, plerumque 10–20 mm lata sed 35–40 mm lata sub ramificatione; laminae monostromaticae praeter venas microscopicas, regiones fertiles, et bases incrassatos; nervi macroscopici absentes; cellulae usitatae vegetativae circa rectangulares, 50–114 μm longae, 24–38 μm latae; sori tetrasporangiorum portati in proliferationibus parvibus dispositis dense secus margines laminae; proliferationes fertiles 265–470 μm latae et 390–780 μm longae; tetrasporangia matura divisa tetrahedraliter 40–56 μm diametro; thalli sexuales ignoti.

The thallus is dark red, reaching a height of 21 cm and consisting of flattened segments with dichotomous or trichotomous branching to four orders (Fig. 10); the segments are 10–20 mm wide but 35–40 mm wide below a di- or trichotomy. Several blades may arise from a single limited attachment pad. The segments are monostromatic except for microscopic veins (Figs. 13, 14), fertile regions, and the somewhat thickened bases; macroscopic nerves are absent. Ordinary vegetative cells are roughly rectangular, measuring about 50–114 μm in length and about 24–48 μm in width. Tetrasporangiate thalli bear sori in small proliferations, which are densely arranged on the margins of the blade (Figs. 11, 12); these proliferations measure 265–470 μm in width and 390–780 μm in length. The mature tetrahedrally divided sporangia are 40–56 μm in diameter. Sexual thalli are unknown.

A single tetrasporangiate specimen from Oman is assigned to *Cryptopleura robusta*. Initially, it was thought that this specimen might be identifiable as *C. membranacea*, a species described by Yamada (1935) from Hutae, Amakusa, Hizen Province, Japan, and apparently known only from Japan. When the Omani specimen was compared to *C. membranacea* based upon accounts by Yamada (1935) and Mikami (1976), it was recognized that a sufficient number of differences exist at the species level that make it impossible to assign the Omani specimen to *C. membranacea* nor to any other species of the genus. The dimensions of the Omani specimen exceed those of *C. membranacea*. In Yamada's (1935) original account



FIGS. 10–14. *Cryptopleura robusta*. 10. Habit of holotype. 11, 12. Marginal proliferations bearing tetrasporangial sori. 13. Surface view of blade showing microscopic vein. 14. Cross section of monostromatic blade showing presence of microscopic veins.

the frond of this species was described as reaching up to about 10 cm in height and having segments of about 1 cm in width “but much broader below the di- or trichotomy.” Points of agreement are the thin membranous nature of the blades (not adhering to paper on drying) and the branching pattern: repeatedly di- or trichotomously or somewhat palmately divided.

The occurrence of the genus *Cryptopleura* in the Indian Ocean was discounted by Silva et al. (1996). With about 17 species currently assigned to it, *Cryptopleura* has a worldwide distribution in warm to cold temperate seas. The type of the genus, *C. ramosa* (Huds.) Kylin ex Newton, bears tetrasporangia in sori inside the margins, just behind blade apices, or in small marginal outgrowths on both sides of the blade (Maggs & Hommersand 1993); it also has both microscopic veins and polystromatic ribs or nerves. Wynne (1987) has discussed the criteria for distinguishing *Cryptopleura* from the related genera *Botryoglossum* and *Hymenena*. In *Botryoglossum*, tetrasporangia are produced in small proliferations borne in clusters over the surface or margins of the primary blades. In *Hymenena*, the tetrasporangial sori are located over the primary blade surface or along the margins of the primary blades. The presence of only microscopic veins in *C. robusta* is a similarity to *Acrosorium*, but in that genus tetrasporangial sori are produced in large sori over the primary blade or on marginal blades but not in the numerous, very small fertile proliferations characteristic of *Cryptopleura* (Wynne 1989, 1996; Maggs & Hommersand 1993).

Rhodomelaceae

Tolypiocladia condensata (Weber Bosse) P. C. Silva

OMAN. Jabal Ali: 4. x. 1983, leg. TMRU.

The genus *Tolypiocladia* is recognized to include three species (Weber-van Bosse 1923, as *Roschera*). In a recent paper (Wynne & Jupp 1998) *T. glomerulata* (C. Agardh) F. Schmitz was reported for the first time from Oman. The younger stages of *T. glomerulata* and *T. calodictyon* (Kütz.) P. C. Silva are very similar, but differences in the habit of the adult plants are significant. Plants of *T. glomerulata* remain fragile throughout their life, tending to be creeping and sprawling over host algae, whereas plants of *T. calodictyon* are weakly developed only in their young stages and later become robust when the primary axes and their branches become surrounded by determinate branches, which anastomose and form a continuous reticulum. *Tolypiocladia condensata* is even more robust, with spongy, well-developed plants up to 1.5 cm in diameter (Weber-van Bosse 1923, as *Roschera condensata*).

PHAEOPHYTA

DICTYOTALES

Dictyotaceae

Dictyopteris macrocarpa (Aresch.) O. C. Schmidt

Fig. 15.

OMAN. Mirbat, Dhofar: 10. xi. 1983, leg. TMRU; rock/sand interface.

This species, described by Areschoug (1847, as *Haliseris macrocarpa*) from Durban, South Africa, has previously been known only from South Africa and Mozambique (Seagrief 1980). The habit has been depicted by several authors (Kützing 1859; Simons 1977; Seagrief 1980, 1988; Branch et al. 1994). The single Omani specimen assigned to this species (Fig. 15) reaches a height of 47 cm, and the width of the blades is (8-) 10-12 (-14) mm. The blade margin is smooth except where torn or branching, and the sori are arranged in two to four roughly longitudinal rows, as has been depicted by Simons (1977). The mature sporangia measure 138-158 µm in diameter.

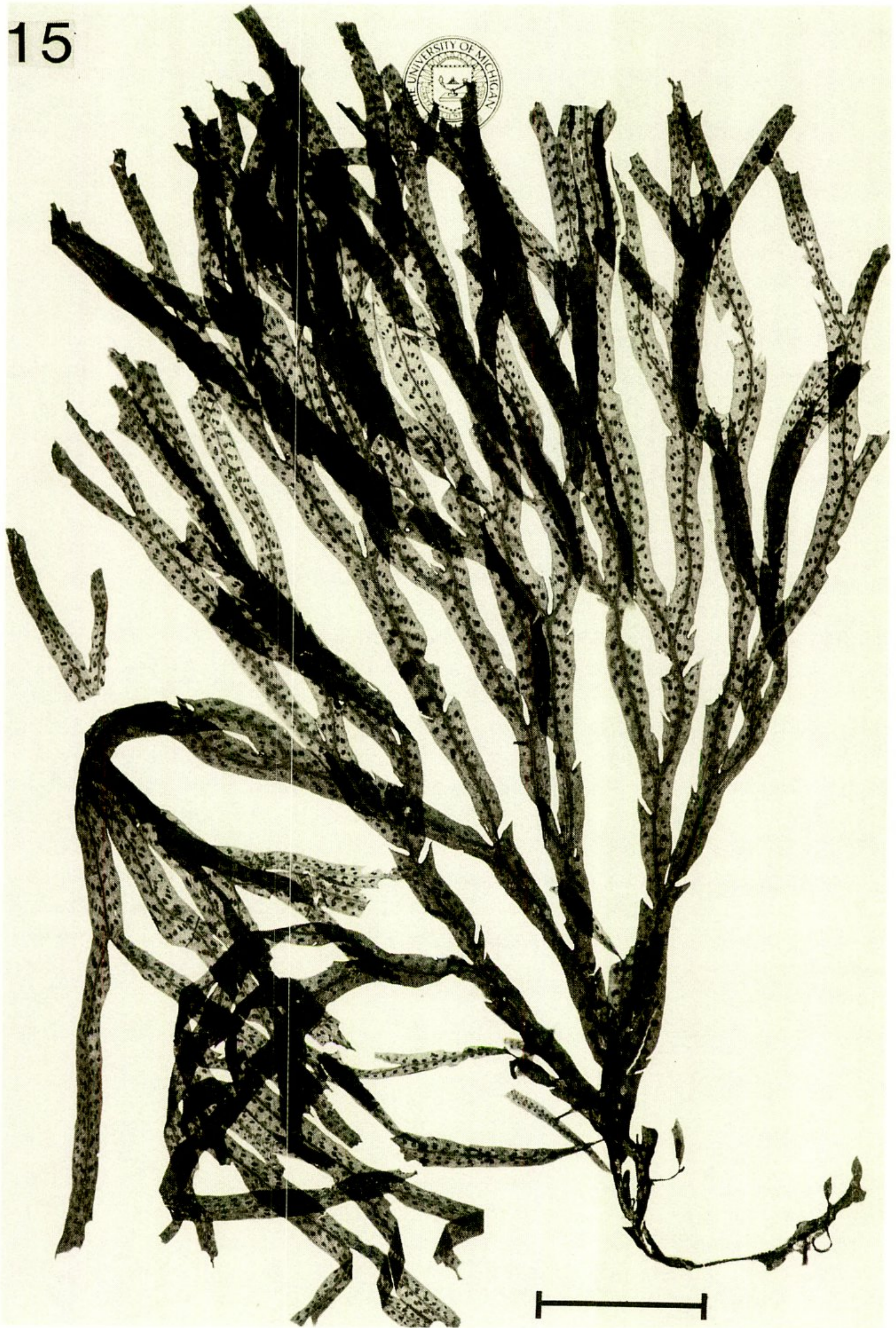


FIG. 15. *Dictyopteris macrocarpa*. Habit of pressed specimen (scale bar: 5 cm).

SPOROCHNALES

Sporochnaceae

Sporochnus pedunculatus (Huds.) C. Agardh Fig. 16.

OMAN. Wadi Haart (Sadh region, 17°04'15"N, 55°06'E): 29. ix. 1983, *L. Barratt*; 5 m. depth.

Sporochnus pedunculatus has not been previously reported from the Indian Ocean, although it has been widely reported from the Northeastern Atlantic from Scandinavia to the Canary Islands (Feldmann 1954; Fletcher 1987; Cabioc'h et al. 1992), the Mediterranean (Zanardini 1861; Feldmann 1937), and the subtropical and tropical Western Atlantic (Taylor 1960; Schneider & Searles 1991). The only species of *Sporochnus* previously reported for the Indian Ocean were those that had been cited from western Australia (Harvey 1855; Womersley 1967), namely, *S. comosus* C. Agardh, *S. radiformis* (Turn.) C. Agardh, and *S. scoparius* Harv. Lüning (1990) characterized *S. pedunculatus* as typically occurring on sandy gravel bottoms, sometimes occurring on solid substrate. Feldmann (1937) and Taylor (1960) described the height of *S. pedunculatus* as exceeding 30 cm, whereas Hamel (1938) and Fletcher (1987) reported the height to reach 50 cm in this species. The single Omani specimen (Fig. 16) has a height of 34 cm. The regularly placed primary branches of the specimen are in good agreement with the figures in Turner (1811), Kützing (1859), and Fletcher (1987). In the Omani specimen the distal portion of the receptacle is not drawn out into a sterile region, the pedicel length is relatively short (390–720 µm long), the receptacle length is 900–1480 µm, and the apical tuft of hairs is 5–8 mm long. There was a problem in using Brostoff's (1984) key to the species of *Sporochnus* with dichotomy #4. In the Omani specimen the receptacles are briefly pedicellate (the receptacles "twice the pedicel length or longer"), which would eventually lead in the Brostoff's key to the Australian *S. comosus* C. Agardh rather than to *S. pedunculatus*. In examining several collections in MICH of presumably authentic *S. pedunculatus*, I observed that often the receptacles are briefly pedicellate, as in the Omani specimen. It is noteworthy that Womersley (1987) stated that *S. comosus* is closely related to *S. pedunculatus*, and he called for detailed comparisons between these two species.

CHLOROPHYTA

BRYOPSIDALES

Bryopsidaceae

Bryopsis maxima Okamura Fig. 17.

OMAN. Al Halaaniyaat Islands (formerly: Kuria Muria Islands), southeast bay near air-strip: 22. x. 1983, 0.3 m depth, *leg. TMRU*.

The Omani material here assigned to *Bryopsis maxima* consists of two specimens (Fig. 17), which measure up to 19 cm in height. This species has been known up to now only from Japan (Okamura 1936). Specimens of Japanese *Bryopsis maxima* in MICH have been compared with the Omani collection. Okamura (1936) indicated the height of the thallus of this species to be 15–20 cm. Segawa (1960) and Chihara (1970) have depicted this species, both indicating a height of up to 20 cm. In a study of *Bryopsis* occurring on the coast of Pakistan, Nizamuddin (1995) reported a total of 16 species, including four new ones. The height of the Pakistani species never exceeded 6 or 7 cm.

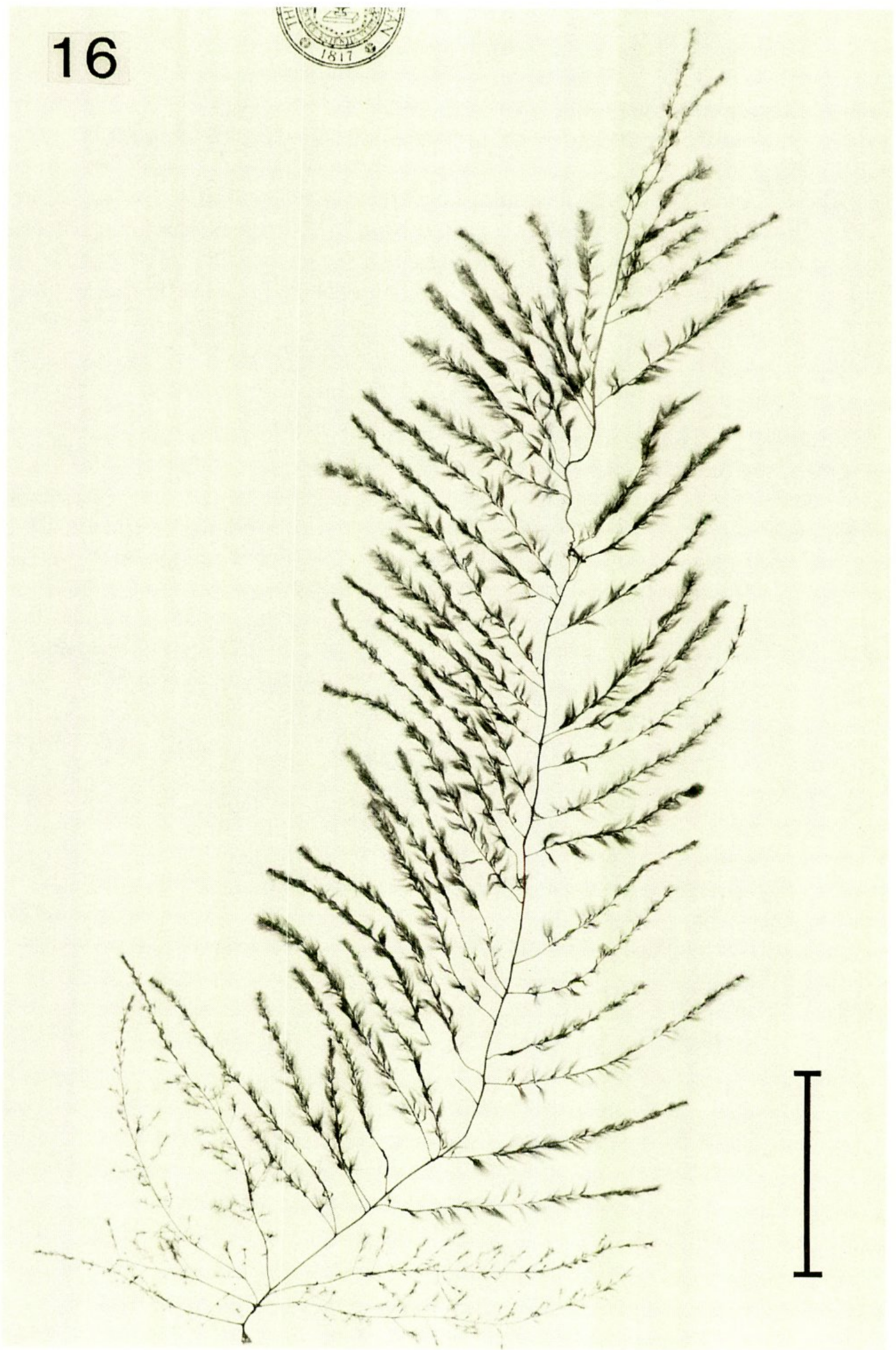


FIG. 16. *Sporochneus pedunculatus*. Habit of pressed specimen (scale bar: 5 cm).

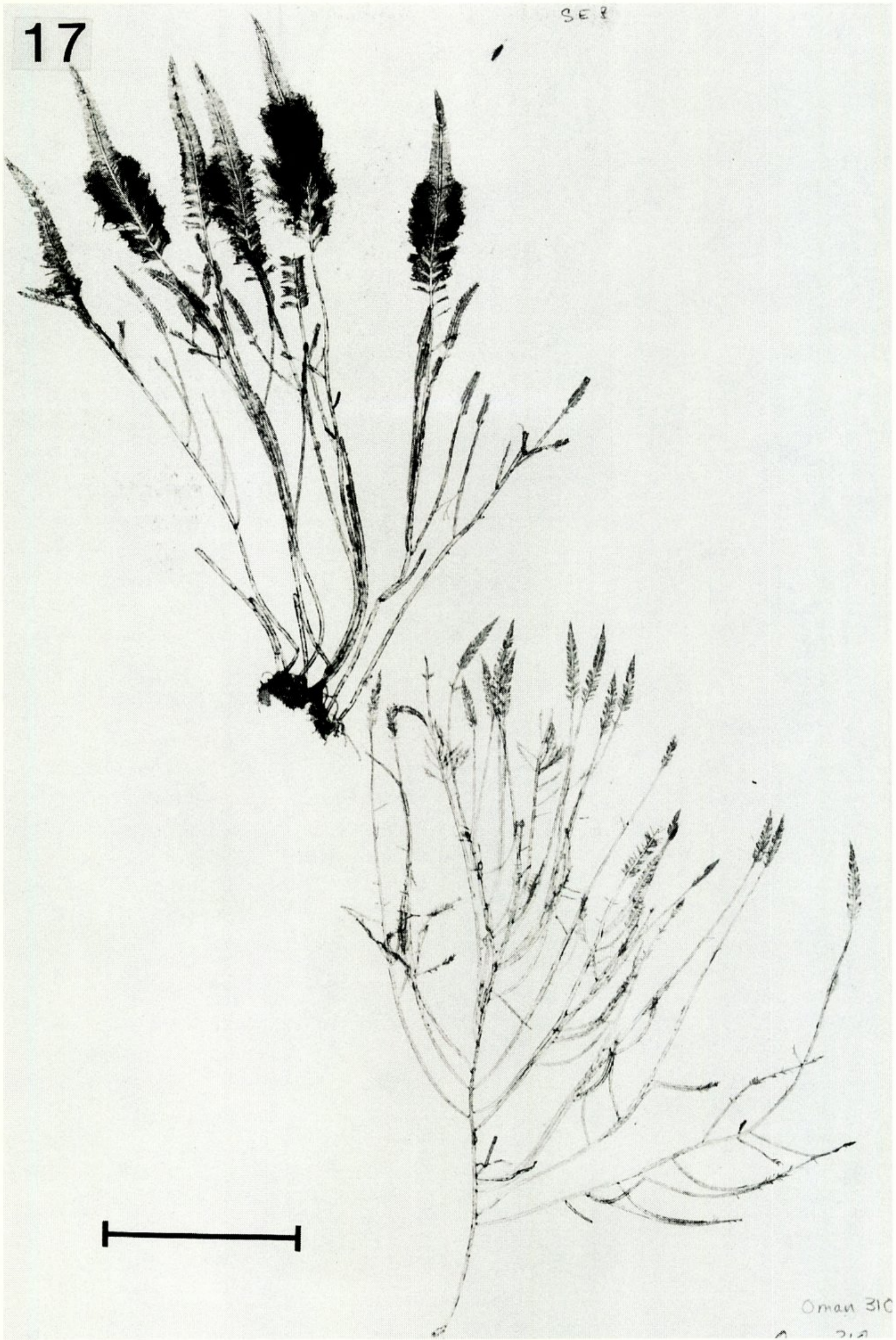
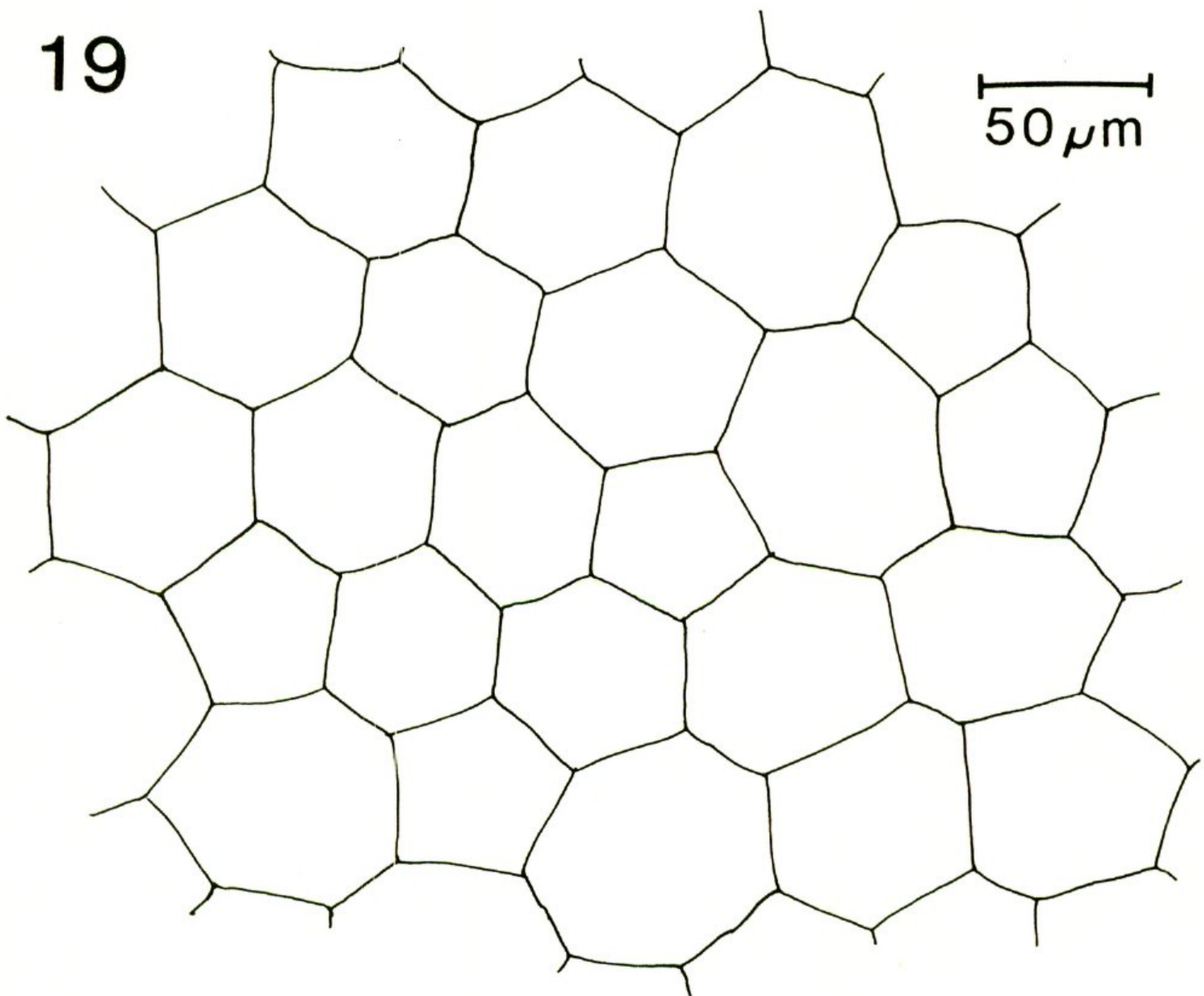
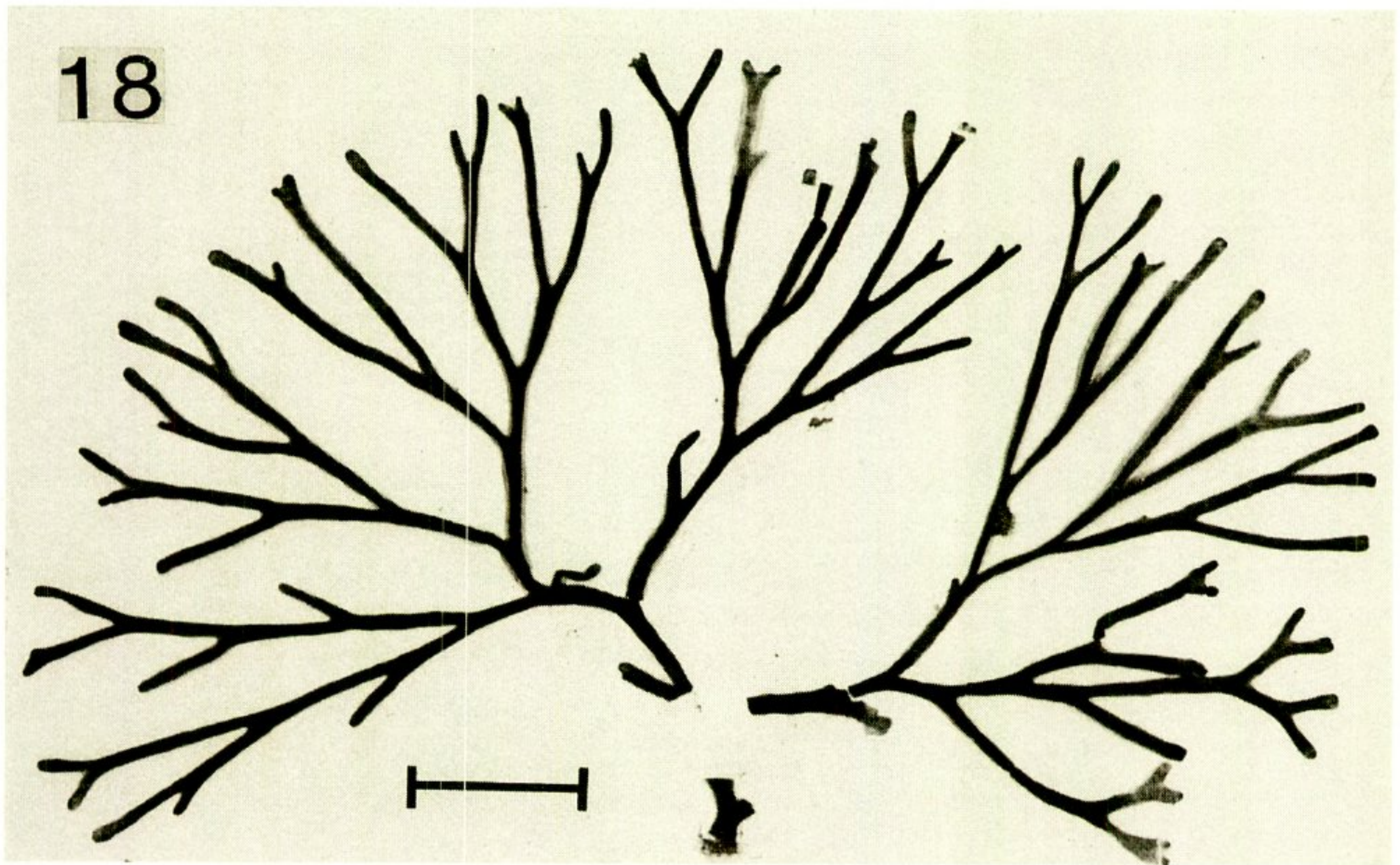


FIG. 17. *Bryopsis maxima*. Habit of pressed specimens (scale bar: 5 cm).



FIGS. 18, 19. *Pseudocodium devriesii*. 18. Habit of pressed specimen (scale bar: 2 cm). 19. Surface pattern of utricles.

Udoteaceae

Pseudocodium devriesii Weber Bosse

Figs. 18, 19.

OMAN. Ras Shabana: 2. xii. 1986; leg. TMRU; 9 m. depth; small rocks and sand.

Pseudocodium devriesii, the type of the genus, was originally described from littoral rocks near Isipinga near Durban, Natal Prov., South Africa (Weber-van Bosse 1896). Its previous known distribution included South Africa (Levring 1938; Seagrief 1988), Madagascar (Farghaly 1980), and Mozambique (Isaac 1956; Pocock 1958). Although the non-calcified, spongy axes (Fig. 18) give the appearance of a terete, dichotomously branched *Codium*, the surface utricles adhere tightly and have a hexagonal appearance in surface view (Fig. 19). The genus has been regarded as more closely related to *Codium* than to *Halimeda* by Gepp and Gepp (1911) and by Dawes and Mathieson (1972), whereas Levring (1938) and Womersley (1955, 1984) regarded it as more closely to *Halimeda* in the Udoteaceae. According to Silva (1982) the genus occupies a position between the Codiaceae and the Udoteaceae in having some features (the presence of mannan as a wall component, a sympodial origin of the utricles, and the lack of leucoplasts) characteristic of the former family and other features (coherence of the utricles and apparent compound gametangia) characteristic of the latter family. It was assigned to its own family by Silva et al. (1996). Two other species of *Pseudocodium* have been recognized: *Ps. australicum* (Womersley 1955) and *Ps. floridanum* (Dawes & Mathieson 1972).

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NEW RECORDS OF BENTHIC MARINE ALGAE
FROM THE SULTANATE OF OMAN

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INTRODUCTION

A prior publication has stressed the relative paucity of work on the marine algal flora of the northern Arabian Sea, particularly the coast of Oman (Wynne & Jupp 1998). Ongoing investigations based on my own collections as well as those made by the Tropical Marine Research Unit of York University, U.K., have led to the recognition of some additional new records and new taxa for this region (Wynne 1998). Some of these new records represent interesting range extensions. The sublittoral and littoral shoreline of southern Oman is greatly influenced by the summertime monsoon with its accompanying upwelling of relatively colder, nutrient-rich waters as well as by the high-energy conditions. In contrast to the elevated salinity values, namely 43.0‰ to 65‰ (-80‰), reported by Basson et al. (1989) for Bahrain in the Arabian (Persian) Gulf, salinity values for the Omani coast have been reported by Savidge et al. (1990) to be close to normal and showing little variation (in the range of 35.5‰ and 35.7‰, rarely in excess of 36.0‰). It is anticipated that this further research on this region will continue to reveal a very rich species diversity of the benthic marine algal flora. All of the specimens referred to in this account have been deposited in the University of Michigan Herbarium (MICH), Ann Arbor. For the specific locations of the collection sites, see Fig. 1 in Wynne and Jupp (1998). The names of authors of taxa are cited according to Brummitt and Powell (1992). "TMRU" indicates that the collections were made by unnamed personnel of the Tropical Marine Research Unit of York University.

RHODOPHYTA

PORPHYRIDIALES

Porphyridiaceae

Stylonema alsidii (Zanardini) K. M. Drew

OMAN. Shinzi, Masirah Island: 6. ii. 1997, Wynne 10935, epiphytic on *Polysiphonia* sp.; Jazirat Thukahr, Masirah Island: 7. ii. 1997, Wynne 10928-B, epiphytic on *Ceramium truncatum* H. E. Petersen in Borgesen.

This widely distributed microscopic alga, which is a common epiphyte on larger seaweeds, has not previously been reported from Oman. *Stylonema* is a genus comprising four species (Kajimura 1992), of which *S. alsidii* is the most frequently reported. Wynne (1985a) reported on the nomenclature of this genus, previously known as *Goniotrichum*.

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ERYTHROPELTIDALES

Erythrotrichiaceae

Erythrotrichia vexillaris (Mont.) Hamel Figs. 1-5.

OMAN. Wadi Forh, 6 km east of Sakh: 2. viii. 1985, leg. T. Wrathall, 1-3 m., epiphytic on *Jolya laminarioides* Guimarfes.

This algal species is in the form of small blades on its host. The young germ-lings (Figs. 1, 2) form simple uniseriate filaments attached by a single rhizoidal cell. The filaments soon flatten out into blades (Figs. 3, 4). Later the mature monostromatic blades are attached by numerous rhizoidal cells produced from the basal part of the blade (Fig. 5). Blades become 1.5-2.0 mm wide and 4.0-5.0 mm long. Taylor (1942) depicted a series of developmental stages, and the Omani material agrees with those figures in having a single attachment cell in the younger stages and multiple rhizoidal cells at the base of larger blades. Vegetative cells are variable in size but are mainly 6-8 μ m wide and 7-10 μ m long. Reproductive cells were not detected. *Erythrotrichia vexillaris* was originally described from Martinique in the West Indies (Montagne 1856); the only previous record of this species from the Indian Ocean is that by Gepp and Gepp (1905) from Christmas Island southwest of Java.

Another foliose species of *Erythrotrichia* is South and Adams's (1974) *E. foliiformis*, described from New Zealand and also reported from Tasmania (Womersley 1994). That species has blades reaching only 0.5 mm in width, but the cell dimensions of the two species, based on my measurements of the Omani specimens and those reported for *E. foliiformis* by South and Adams (1974), are the same. According to Taylor (1942) width of cells varies according to the age of the plant and the recency of division: before division 13-15 μ m wide and after division 7.5-10.9 μ m wide. Filamentous cells assuming a stellate shape in the blades of *E. foliiformis* (of unknown function) are not reported in *E. vexillaris*. Womersley (1994) described *E. ligulata* from southern Australia, a small foliose species with numerous simple ligulate blades arising from a well-developed multicellular basal disc. Womersley expressed doubt that *E. vexillaris* and *E. foliiformis* belong to *Erythrotrichia* because of their multi-rhizoidal bases.

GIGARTINALES

Rhizophyllidaceae

Portieria japonica (Harv.) P. C. Silva

OMAN. Raysut: 23. iv. 1983, intertidal pools; leg. L. Barratt.

This species was first described by Harvey (1860, as *Desmia japonica*) from Shimoda (Shizuoka Prefecture) Japan. It was later transferred to *Chondrococcus* by DeToni (1895). Silva (in Silva et al. 1987) explained that the generic name *Chondrococcus* (Kützting 1847) could no longer be used for the material being assigned to it, and he resurrected the generic name *Portieria* (Zanardini 1851) to encompass those species formerly assigned to *Chondrococcus*.

Portieria hornemannii (Lyngb.) P. C. Silva, the type of the genus, is a much more frequently encountered species and has a much broader distribution than *P. japonica*. The former species has been reported from Oman (Silva et al. 1996). Okamura (1922, pi. 190) depicted both *P. hornemannii* and *P. japonica* from

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FIGS. 1-5. *Erythrotrichia vexillaris*. 1, 2. Young filamentous germlings. 3, 4. Early foliose stages. 5. Numerous rhizoidal cells from basal attachment portion of a mature thallus.

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Japan. He indicated that *P. japonica* differs in the breadth of the frond: 2-3 mm broad in comparison to 1-2 mm broad in *P. hornemannii*. The ultimate branches in *P. japonica* tend to be blunt and obtuse rather than the sharply pointed, simple or divaricately branched final branches of *P. hornemannii*. Also, branching in *P. hornemannii* is often to 5 orders, whereas in *P. japonica* branching is to 3 orders. The Oman specimen assigned to *P. japonica* is 11 cm in height, branched to 5 orders, and has axes reaching 2.5 mm in width. This record represents the first report of *P. japonica* from the Indian Ocean.

Hypneaceae

Hypnea boergesenii Tak. Tanaka Fig. 6.

OMAN. Al Halaaniyaat Islands (formerly Kuria Muria Islands), southeast bay on runway: 22. x. 1983, leg. TMRU; tetrasporangiate and cystocarpic plants.

Tanaka (1941) distinguish 6 *Hypnea boergesenii* from the 13 other species in his monographic treatment of the genus on the basis of the erect main axes that are cylindrical and densely bearing lateral branchlets throughout the length of the frond of this species. These features are also characteristic of the specimens from Oman (Fig. 6). Tanaka (1941) reported the height of his material to be 6-13 cm; the height of the Omani plants reaches 32 cm. Tanaka regarded his new species to be closely related to *H. spicifera* Harv. but differing by its axial stem and the shape of its spinous branchlets. This species has been characterized by Dawson (1954) as having exceedingly abundant, short ultimate lateral branchlets, the tips of some of these ultimate branchlets divaricate. A closely related species is *H. flagelliformis* Grev. ex J. Agardh (1852), which also has axes densely covered with simple or divaricate branchlets or spinules (Yendo 1916). Tanaka (1941) separated the species by the absence of lateral branches in the basal part of the frond of *H. flagelliformis*. Also, lenticular wall thickenings of the medullary cells do not occur in *H. flagelliformis* but are present in the basal part of the frond of *H. boergesenii* (Chiang 1997; Xia & Wang 1997).

Hypnea boergesenii was described by Tanaka (1941) from Keelung, northern Taiwan (see also Chiang, 1997), and has also been reported from central to southern China (Tseng 1983; Xia & Wang 1997), Vietnam (Dawson 1954), and New South Wales, Australia (Millar 1990). It has not yet been reported from Japan (Yoshida et al. 1995), and its only previous reports from the Indian Ocean have been by Isaac (1968) from Kenya and by Islam (1976) from Bangladesh.

HALYMENIALES

Halymeniaceae

Cryptonemia coriacea F. Schmitz

OMAN. Sadh headland: 20. ix. 1985, T. Cadle, 16 m depth.

Originally described from Tanzania (Schmitz 1895), *Cryptonemia coriacea* has also been reported from India and Pakistan by Borgesen (1937). Borgesen (1937) recognized that the very large Karachi specimens that he had identified earlier as *C. undulata* Sond. (Borgesen 1932) should be referred to *C. coriacea*. According to Borgesen specimens of *C. undulata* are much smaller, more delicate, and with a very much undulated margin. Similarly, Desikachary et al. (1990) distinguished *C. coriacea*

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FIGS. 6, 7. *Hypnea boergesenii* and *Rhodymenia dissecta*. 6. *Hypnea boergesenii*, habit of pressed specimen (scale bar: 5 cm). 7. *Rhodymenia dissecta*, habit of pressed specimen (scale bar: 2 cm).

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from *C. undulata* in that the former has marginal proliferations rather than proliferations arising only from the midrib; the branching of *C. coriacea* results in blades that are palmately or irregularly divided rather than the dichotomous pattern of *C. undulata*. The single Omani specimen has small marginal proliferations. In both species there is a prominent midrib in the basal portion of the blade, which gradually disappears in the upper portion.

RHODYMENIALES

Rhodymeniaceae

Rhodymenia dissecta Borgesen

Fig. 7.

OMAN. Wadi Haart Reef: 7. x. 1983, leg. TMRU, 6 m. and 12 m., Sargassum community. Western side of Wadi Zead ("Hoon's Bay"), 20 km east of Mirbat: 21. x. 1983, leg. TMRU, 17 m., Ecklonia forest. Sadh headland: 20. ix. 1985, leg. T. Cadle, 15 m., Ecklonia community. Ras Shabana: 31. x. 1986, leg. TMRU, 9 m., rock/sand interface, 6. Wadi Feshree: 15. xi. 1986, leg. TMRU, 9 m., on sand/coral substrate, 8.

Borgesen (1938) described this species from Tuticorin, India, and it has been also reported from Yemen (Ormond & Banaimoon 1994). The eight specimens assigned to this species range in height from 5 to 10 cm, and their axes in width generally from 2 to 4 mm. There is a gradual reduction in blade width in the distal portions, the final orders of branches becoming narrowed to 1 mm. One large tetrasporangiate specimen is branched up to 9 orders, which exceeds the "up to six times" reported by Borgesen (1938). A terete stoloniferous system is lacking. In the specimens with intact basal systems (Fig. 7), attachment to the substrata (usually articulated coralline red algae) is made by multiple points arising from the basal part of the *Rhodymenia*, and some of the tips of smaller branches have produced small, narrow holdfasts. Marginal proliferations are not present near the base, but tetrasporangia are present in sori near the apices of the regular axes and also on small proliferations arising near the blade margins. These fertile proliferations are 5 mm long and 1.2-1.8 mm wide. The cruciately divided tetrasporangia are elongate-ovoid, 14-18 μ m long and 7-10 μ m wide, and are produced in nemathecia. Cross-sections of mature blades measure 160-190 μ m in thickness. The walls of some medullary cells were unevenly thickened and refractive, a feature not previously known to occur in *Rhodymenia* but common in some species of *Hypnea*, *Laurencia*, and *Chondria*.

This species bears similarity to *Rhodymenia leptophylla* J. Agardh, known from New Zealand (Adams 1994) and Australia (Millar 1990; Womersley 1996). That species has a stoloniferous basal system and a terete stipe unlike the flattened basal stalk of *R. dissecta*. There also is some resemblance to *R. natalensis* Kylin and *R. sonderi* P. C. Silva (formerly *R. australis* Sond.).

CERAMIALES

Ceramiaceae

Ceramium mazatlanense E. Y. Dawson

OMAN. Sur Beach Resort Hotel, Sur: 31. i. 1997, Wynne (Oman 255), sterile, in sandy turf with other algae.

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First described from Pacific Mexico (Dawson 1950), this species has been recorded to have a broad distribution in the tropical and subtropical Indo-Pacific (Dawson 1954; Jaasund 1970; Womersley & Bailey 1970; Cribb 1983; Wynne 1995). Although the Omani material was apparently sterile, the species determination could be made on the basis of the prostrate habit, the reduced stature, the dichotomous branching and strongly forcipate tips, and the nodal cortication comprised of angular cells in a non-regular alignment.

Ceramium subdichotomum Weber Bosse

Figs. 8. 9.

OMAN. Jazirat Thukhayr, Masirah Island: 7. ii. 1997, Wynne 10962, epiphytic on *Padina*.

This species, described from Indonesia (Weber-van Bosse 1923), has also been reported from India (Borgesen 1938) and the Seychelles (Wynne 1995). Significant points of agreement with *Ceramium subdichotomum* are the primary creeping filament, the overall small size of the thallus, the subdichotomous branching (Fig. 8), the mature axes reaching a width of 150 to 350 μm , and the mature segments having a greater width than length. A conspicuous feature of the Omani material is the abundant presence of gland cells scattered in among the nodal cells (Fig. 9), a character not noted by Weber-van Bosse (1923) in her account. Yet this determination seems justified in light of the other similarities and the fact that the presence of gland cells is not considered a reliable character (Womersley 1978).

The Omani material shows a great amount of morphological variation. Thalli showing greatest similarity to Weber-van Bosse's (1923) description of *Ceramium subdichotomum* appear to be those no longer exhibiting active growth (Fig. 8), whereas the more actively growing plants have apices more strongly forcipate and with nodes separated by longer and narrower internodes. A transition between these two patterns is obvious.

Several other species of *Ceramium* are known to have gland cells present in among their nodal cells. For example, *C. glanduliferum* Kylin from South Africa has a ring of 5 to 10 yellow-brown ovoid gland cells, but they are restricted to a whorl at the distal end of each nodal band (Kylin 1938; Stegenga et al. 1997). In *C. clarionense* Setch. & N. L. Gardner the nodal bands contain a large number of scattered small gland cells (Setchell & Gardner 1930). The axes in that species, however, show regularly dichotomous branching with circinate-forcipate apices. Gland cells may occur in *C. flaccidum* (Ktitz.) Ardiss. That species differs from *C. subdichotomum* in having its cortical bands separated into acropetal and basipetal parts by a horizontal space (Womersley 1978).

Ceramium truncatum H. E. Petersen in Borgesen

OMAN. Sath, Dhofar: 20. ix. 1985, L. Barratt, epiphytic on foliose red algae; Shinzi, Masirah Island: 6. ii. 1997, Wynne 10889, , epiphytic on *Meristotheca papulosa* (Mont.) J. Agardh; Jazirat Thukhayr, Masirah Island: 7. ii. 1997, Wynne 10928-A, , epiphytic on *Meristotheca papulosa*.

In addition to its epiphytic habit, other points of agreement between the Omani collection and Petersen's (in Borgesen, 1936) account of *Ceramium truncatum* are the erect (non-forcipate) nature of the apices, and the fact that the cortication is continuous close to the growing points but becoming distinct in older axes. The cruciately divided tetrasporangia are usually paired but also borne singly per segment and in three's (whorled), and covered by outer involucrel filaments. Axes are 80-88 μm wide, and nodal bands consist of about 6 or 7 irregularly arranged rows of cells.

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FIGS. 8, 9. *Ceramium subdichotomum*. 8. Apices showing subdichotomous branching. 9. Gland cells abundantly present in the nodal bands. Scale bar: 50 μ m.

Dasyaceae

Dasya rigidula (Kiitz.) Ardiss.

OMAN. Shinzi, Masirah Island: 6. ii. 1997, Wynne 10932; epiphytic on *Spyridia hypnoides* (Bory) Papenf.

This report of *Dasya rigidula* from Oman appears to represent the first record of this species from the Indian Ocean. First described from Split in the Adriatic by Kutzing (1843, 1849, as ?*Eupogonium rigidulum*), its distribution was later extended into the western Mediterranean (Ardissone 1883; Gallardo et al. 1985; Boudouresque & Perret-Boudouresque 1987), Atlantic Iberian Peninsula (Ardre 1970), and to the tropical and subtropical western Atlantic (Howe 1920; Taylor 1960; Oliveira & Ugadim 1974; Schneider & Searles 1991). Thalli of *D. rigidula* are small (1-2 cm tall), and the axes are typically ecorticate but becoming lightly corticated in basal regions. Pseudolaterals are borne from every segment in a radial arrangement, and the branches of the pseudolaterals are divaricate. The basal segment of the pseudolaterals are monosiphonous; indeterminate branches occasionally replace pseudolaterals. *Dasya rigidula* can possibly be confused with *Heterosiphonia crispella* (C. Agardh) M. J. Wynne, but the latter species, which is also very lightly corticated, has bilaterally arranged pseudolaterals, arising from every other segment and provided with a polysiphonous basal segment (Wynne 1985b).

There is some similarity between *Dasya rigidula* and *D. iyengarii* Borgesen, described from India (Borgesen 1937). Thalli of *D. iyengarii* are described as forming small, dense, soft, much ramified tufts, 3-4 cm high, with weakly developed

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cortication. But unlike the divaricate branches of the pseudolaterals in *D. rigidula*, those in *D. iyengarii* are curved and hook-shaped (Borgesen 1937; Krishnamurthy & Varadarajan 1991).

The relationship of *Dasya rigidula* with *D. hutchinsiae* Harv. is uncertain. It has been suggested by Athanasiadis (1987) that the former may be a taxonomic synonym of the latter. Athanasiadis (1987) found small (to 2 cm tall) specimens with sparse cortication from the Sithonia Peninsula in the northern Aegean Sea, and he thought that earlier reports of *D. rigidula* from the region by Coppejans (1974) corresponded to his material of *D. hutchinsiae*. Schneider and Searles (1991) reported *Dasya rigidula* from North Carolina, noting that specimens from Onslow Bay were significantly larger (to 8 cm) than the 2 cm height reported by Taylor (1960) for *D. rigidula* in the western Atlantic. Schneider and Searles (1991) also noted that the main axes of these larger specimens showed more cortication than the smaller, mostly ecorticate specimens, but these authors made no reference to *D. hutchinsiae*.

Delesseriaceae

Cryptopleura robusta M. J. Wynne, sp. nov. -TYPE: OMAN. Sadh headland, west of Sadh Bay: 21. xi. 1985, L. Barratt, 25 m. depth; (holotype: MICH!).

Figs. 10-14.

Thallus atroruber, usque ad 21 cm altus; segmenta plana ramificatione dichotoma vel trichotoma, usque ad quattuor ordines, plerumque 10-20 mm lata sed 35-40 mm lata sub ramificatione; laminae monostromaticae praeter venas microscopicas, regiones fertiles, et bases incrassatos; nervi macroscopici absentes; cellulae usitatae vegetativae circa rectangulares, 50-114 μ m longae, 24-38 μ m latae; sori tetrasporangiorum portati in proliferationibus parvibus dispositis dense secus margines laminae; proliferationes fertiles 265-470 μ m latae et 390-780 μ m longae; tetrasporangia matura divisa tetrahedraliter 40-56 μ m diametro; thalli sexuales ignoti.

The thallus is dark red, reaching a height of 21 cm and consisting of flattened segments with dichotomous or trichotomous branching to four orders (Fig. 10); the segments are 10-20 mm wide but 35-40 mm wide below a di- or trichotomy. Several blades may arise from a single limited attachment pad. The segments are monostromatic except for microscopic veins (Figs. 13, 14), fertile regions, and the somewhat thickened bases; macroscopic nerves are absent. Ordinary vegetative cells are roughly rectangular, measuring about 50-114 μ m in length and about 24-48 μ m in width. Tetrasporangiate thalli bear sori in small proliferations, which are densely arranged on the margins of the blade (Figs. 11, 12); these proliferations measure 265-470 μ m in width and 390-780 μ m in length. The mature tetrahedrally divided sporangia are 40-56 μ m in diameter. Sexual thalli are unknown.

A single tetrasporangiate specimen from Oman is assigned to *Cryptopleura robusta*. Initially, it was thought that this specimen might be identifiable as *C. membranacea*, a species described by Yamada (1935) from Hutae, Amakusa, Hizen Province, Japan, and apparently known only from Japan. When the Omani specimen was compared to *C. membranacea* based upon accounts by Yamada (1935) and Mikami (1976), it was recognized that a sufficient number of differences exist at the species level that make it impossible to assign the Omani specimen to *C. membranacea* nor to any other species of the genus. The dimensions of the Omani specimen exceed those of *C. membranacea*. In Yamada's (1935) original account

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Fig. 10-14. *Cryptopleura robusta*. 10. Habit of holotype. 11, 12. Marginal proliferations bearing tetrasporangial sori. 13. Surface view of blade showing microscopic vein. 14. Cross section of monostromatic blade showing presence of microscopic veins.

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FIGS. 10-14. *Cryptopleura robusta*. 10. Habit of holotype. 11, 12. Marginal proliferations bearing tetrasporangial sori. 13. Surface view of blade showing microscopic vein. 14. Cross section of monostromatic blade showing presence of microscopic veins.

the frond of this species was described as reaching up to about 10 cm in height and having segments of about 1 cm in width "but much broader below the di- or trichotomy." Points of agreement are the thin membranous nature of the blades (not adhering to paper on drying) and the branching pattern: repeatedly di- or trichotomously or somewhat palmately divided.

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The occurrence of the genus *Cryptopleura* in the Indian Ocean was discounted by Silva et al. (1996). With about 17 species currently assigned to it, *Cryptopleura* has a worldwide distribution in warm to cold temperate seas. The type of the genus, *C. ramosa* (Huds.) Kylin ex Newton, bears tetrasporangia in sori inside the margins, just behind blade apices, or in small marginal outgrowths on both sides of the blade (Maggs & Hommersand 1993); it also has both microscopic veins and polystromatic ribs or nerves. Wynne (1987) has discussed the criteria for distin-

guishing *Cryptopleura* from the related genera *Botryoglossum* and *Hymenena*. In *Botryoglossum*, tetrasporangia are produced in small proliferations borne in clusters over the surface or margins of the primary blades. In *Hymenena*, the tetrasporangial sori are located over the primary blade surface or along the margins of the primary blades. The presence of only microscopic veins in *C. robusta* is a similarity to *Acrosorium*, but in that genus tetrasporangial sori are produced in large sori over the primary blade or on marginal blades but not in the numerous, very small fertile proliferations characteristic of *Cryptopleura* (Wynne 1989, 1996; Maggs & Hommersand 1993).

Rhodomelaceae

Tolypocladia condensata (Weber Bosse) P. C. Silva
OMAN. Jabal Ali: 4. x. 1983, leg. TMRU.

The genus *Tolypocladia* is recognized to include three species (Weber-van Bosse 1923, as *Roschera*). In a recent paper (Wynne & Jupp 1998) *T. glomerulata* (C. Agardh) F. Schmitz was reported for the first time from Oman. The younger stages of *T. glomerulata* and *T. calodictyon* (Kutz.) P. C. Silva are very similar, but differences in the habit of the adult plants are significant. Plants of *T. glomerulata* remain fragile throughout their life, tending to be creeping and sprawling over host algae, whereas plants of *T. calodictyon* are weakly developed only in their young stages and later become robust when the primary axes and their branches become surrounded by determinate branches, which anastomose and form a continuous reticulum. *Tolypocladia condensata* is even more robust, with spongy, well-developed plants up to 1.5 cm in diameter (Weber-van Bosse 1923, as *Roschera condensata*).

PHAEOPHYTA

DICTYOTALES

Dictyotaceae

Dictyopteris macrocarpa (Aresch.) O. C. Schmidt Fig. 15.
OMAN. Mirbat, Dhofar: 10. xi. 1983, leg. TMRU; rock/sand interface.

This species, described by Areschoug (1847, as *Haliseris macrocarpa*) from Durban, South Africa, has previously been known only from South Africa and Mozambique (Seagrief 1980). The habit has been depicted by several authors (Kutzing 1859; Simons 1977; Seagrief 1980, 1988; Branch et al. 1994). The single Omani specimen assigned to this species (Fig. 15) reaches a height of 47 cm, and the width of the blades is (8-) 10-12 (-14) mm. The blade margin is smooth except where torn or branching, and the sori are arranged in two to four roughly longitudinal rows, as has been depicted by Simons (1977). The mature sporangia measure 138-158 µm in diameter.

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FIG. 15. *Dictyopteris macrocarpa*. Habit of pressed specimen (scale bar: 5 cm).

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SPOROCHNALES

Sporochnaceae

Sporochnus pedunculatus (Huds.) C. Agardh Fig. 16.

OMAN. Wadi Haart (Sadh region, 1704'15"N, 5506'E): 29. ix. 1983, L. Barratt; 5 m. depth.

Sporochnus pedunculatus has not been previously reported from the Indian Ocean, although it has been widely reported from the Northeastern Atlantic from Scandinavia to the Canary Islands (Feldmann 1954; Fletcher 1987; Cabioc'h et al. 1992), the Mediterranean (Zanardini 1861; Feldmann 1937), and the subtropical and tropical Western Atlantic (Taylor 1960; Schneider & Searles 1991). The only species of *Sporochnus* previously reported for the Indian Ocean were those that had been cited from western Australia (Harvey 1855; Womersley 1967), namely, *S. comosus* C. Agardh, *S. radiformis* (Turn.) C. Agardh, and *S. scoparius* Harv. Lining (1990) characterized *S. pedunculatus* as typically occurring on sandy gravel bottoms, sometimes occurring on solid substrate. Feldmann (1937) and Taylor (1960) described the height of *S. pedunculatus* as exceeding 30 cm, whereas Hamel (1938) and Fletcher (1987) reported the height to reach 50 cm in this species. The

single Omani specimen (Fig. 16) has a height of 34 cm. The regularly placed primary branches of the specimen are in good agreement with the figures in Turner (1811), Kutzing (1859), and Fletcher (1987). In the Omani specimen the distal portion of the receptacle is not drawn out into a sterile region, the pedicel length is relatively short (390-720 µm long), the receptacle length is 900-1480 µm, and the apical tuft of hairs is 5-8 mm long. There was a problem in using Brostoff's (1984) key to the species of *Sporocnhus* with dichotomy #4. In the Omani specimen the receptacles are briefly pedicellate (the receptacles "twice the pedicel length or longer"), which would eventually lead in the Brostoff's key to the Australian *S. comosus* C. Agardh rather than to *S. pedunculatus*. In examining several collections in MICH of presumably authentic *S. pedunculatus*, I observed that often the receptacles are briefly pedicellate, as in the Omani specimen. It is noteworthy that Womersley (1987) stated that *S. comosus* is closely related to *S. pedunculatus*, and he called for detailed comparisons between these two species.

CHLOROPHYTA

BRYOPSIDALES

Bryopsidaceae

Bryopsis maxima Okamura

Fig. 17.

OMAN. Al Halaaniyaat Islands (formerly: Kuria Muria Islands), southeast bay near air-strip: 22. x. 1983, 0. 3 m depth, leg. TMRU.

The Omani material here assigned to *Bryopsis maxima* consists of two specimens (Fig. 17), which measure up to 19 cm in height. This species has been known up to now only from Japan (Okamura 1936). Specimens of Japanese *Bryopsis maxima* in MICH have been compared with the Omani collection. Okamura (1936) indicated the height of the thallus of this species to be 15-20 cm. Segawa (1960) and Chihara (1970) have depicted this species, both indicating a height of up to 20 cm. In a study of *Bryopsis* occurring on the coast of Pakistan, Nizamuddin (1995) reported a total of 16 species, including four new ones. The height of the Pakistani species never exceeded 6 or 7 cm.

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FIG. 16. *Sporochnus pedunculatus*. Habit of pressed specimen (scale bar: 5 cm).

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FIG. 17. *Bryopsis maxima*. Habit of pressed specimens (scale bar: 5 cm).

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FIGS. 18, 19. *Pseudocodium devriesii*. 18. Habit of pressed specimen (scale bar: 2 cm). 19. Surface pattern of utricles.

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Udoteaceae

Pseudocodium devriesii Weber Bosse

Figs. 18, 19.

OMAN. Ras Shabana: 2. xii. 1986; leg. TMRU; 9 m. depth; small rocks and sand.

Pseudocodium devriesii, the type of the genus, was originally described from littoral rocks near Isipinga near Durban, Natal Prov., South Africa (Weber-van Bosse 1896). Its previous known distribution included South Africa (Levring 1938; Seagrief 1988), Madagascar (Farghaly 1980), and Mozambique (Isaac 1956; Pocock 1958). Although the non-calcified, spongy axes (Fig. 18) give the appearance of a terete, dichotomously branched *Codium*, the surface utricles adhere tightly and have a hexagonal appearance in surface view (Fig. 19). The genus has been regarded as more closely related to *Codium* than to *Halimeda* by Gepp and Gepp (1911) and by Dawes and Mathieson (1972), whereas Levring (1938) and Womersley (1955, 1984) regarded it as more closely related to *Halimeda* in the Udoteaceae. According to Silva (1982) the genus occupies a position between the Codiaceae and the Udoteaceae in having some features (the presence of mannan as a wall component, a

sympodial origin of the utricles, and the lack of leucoplasts) characteristic of the former family and other features (coherence of the utricles and apparent compound gametangia) characteristic of the latter family. It was assigned to its own family by Silva et al. (1996). Two other species of *Pseudocodium* have been recognized: *Ps. australicum* (Womersley 1955) and *Ps. floridanum* (Dawes & Mathieson 1972).

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